Joint Cost and Schedule Probabilistic Estimating and Budgeting Policy at NASA

February 2009

What?

- NASA wants to establish realistic program and project budgets that reflect a reasonable chance of achieving technical, cost and schedule objectives and commitments

Why?

- We need to meet the expectations of stakeholders
- Getting it wrong
  - Damages our reputation as good stewards of public resources
  - Inhibits our ability to obtain funds for future programs and projects
  - Has adverse impacts of other programs and projects in our portfolio

How?

- Establish budgets based on the probability that projects have a better than 50/50 change of meeting cost and schedule targets

Why Are Cost Estimates Uncertain?

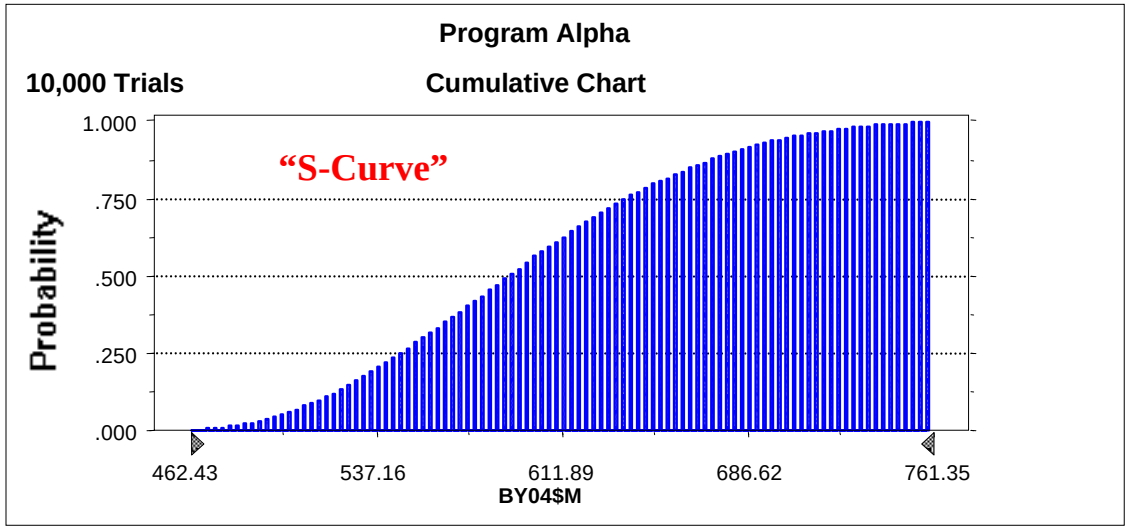
- **Beyond-State-of-the-Art Technology**
  - Cooling
  - Processing
  - Survivability
  - Power
  - Laser Communications
- **Partners failing to meet commitments**
- **Launch conflicts**
- **Tight Schedules**
  - Undeveloped Technology
  - Software Development
  - Supplier Viability
- **System Integration**
  - Multi-Contractor Teams
  - System Testing
- **Limited Resources**
- **Program Funding Stretch-out**
- **Premature Commitment to R&D Phase**
- **Unforeseen Events**

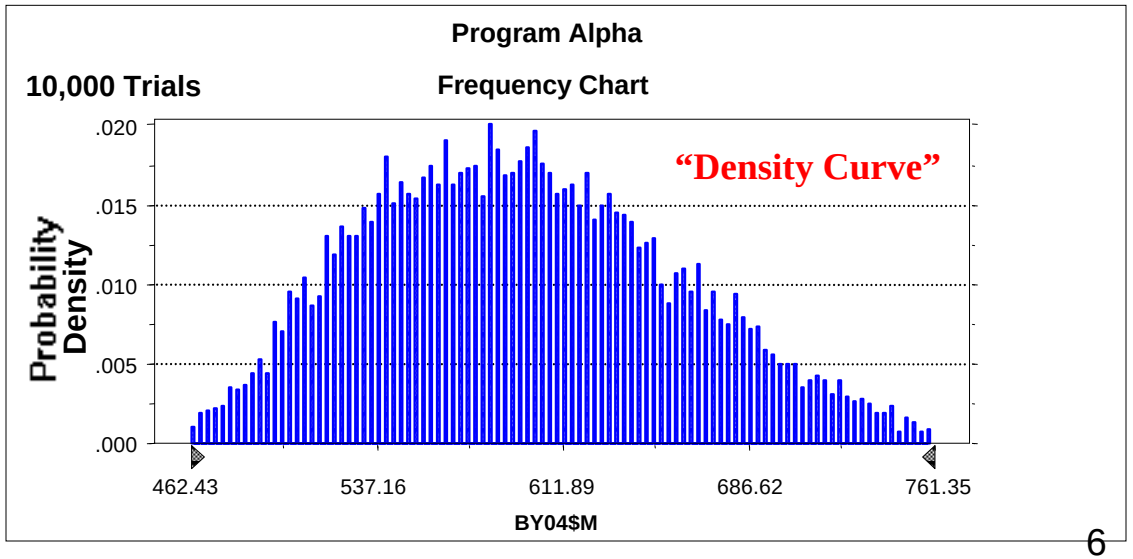
These are just a few examples

What a Cost Estimate Looks Like

Percentile	Value
10%	516.81
20%	538.98
30%	557.85
40%	575.48
50%	592.72
60%	609.70
70%	629.19
80%	650.97
90%	683.01

Statistics	Value
Trials	10,000
Mean	596.40
Median	592.72
Mode	---
Standard Deviation	63.18
Range Minimum	450.19
Range Maximum	796.68





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So, Where Should We Set the Budget?

- *There is no "best" answer*
- The "answer" depends on the amount of budget available or requested, and the amount of risk the decision-maker is willing to take
- A risk-averse decision-maker would probably choose a budget reflecting a cost with a high probability of realization
  - To minimize the probability of a cost overrun
- A risk-tolerant decision-maker might budget at a lower number, channeling a program manager to greater risk management
- Budget decisions should consider the risk across the entire portfolio of programs

NASA's Policy on Setting Budgets Based on Probability

- In March of 2006, NASA Administrator
  - "Griffin determined that NASA's standard practices will be to budget projects at a 70% confidence level based on the independent cost estimate. Any proposed deviations from this standard must be brought forward for consideration to the appropriate management council."
  - "… initiate a pattern of honest dealing between Program and Project Managers, HQ, the Congress, and the WH, and to avoid the pattern of finger-pointing for cost overruns and schedule slips that have plagued the industry in the past".
- Since this policy was declared, nearly all the major projects that came before the Agency Program Management Council were budgeted less than 70 percent probability of success (confidence level). Many reasons exist, but a few follow
  - No clear agreement on the estimate that should be used
  - Difficulty reconciling project estimates (typically based on engineering build up) with the Independent Estimates that were done using parametric models
  - Estimates were insensitive to schedule uncertainty
  - Belief that projects should be challenged
- NASA changed the policy (and formally documented it) on January 16, 2009

Management Intent of New Policy

- Confidence level policy needs to be more explicit about meeting schedule commitments in addition to cost -- move to a joint cost and schedule probability of success
- Probability of success should be based on project's estimate/plan
- Confidence policy needs to be more flexible
  - Set the confidence policy at the program level
  - Allow program to solve issues by changing content and use resources within the programs' control
  - Use other resources, but with better accountability
- At KDPs
  - Projects must develop and defend good plans at KDPs
  - SRB to assess project plans vice developing and presenting independent PCEs

A Summary of the New Confidence Level Policy

- All space flight and information technology programs shall develop a joint cost and schedule probabilistic analysis and be baselined or rebaselined and budgeted such that there is a 70 percent probability of achieving the stated life cycle cost and launch schedule

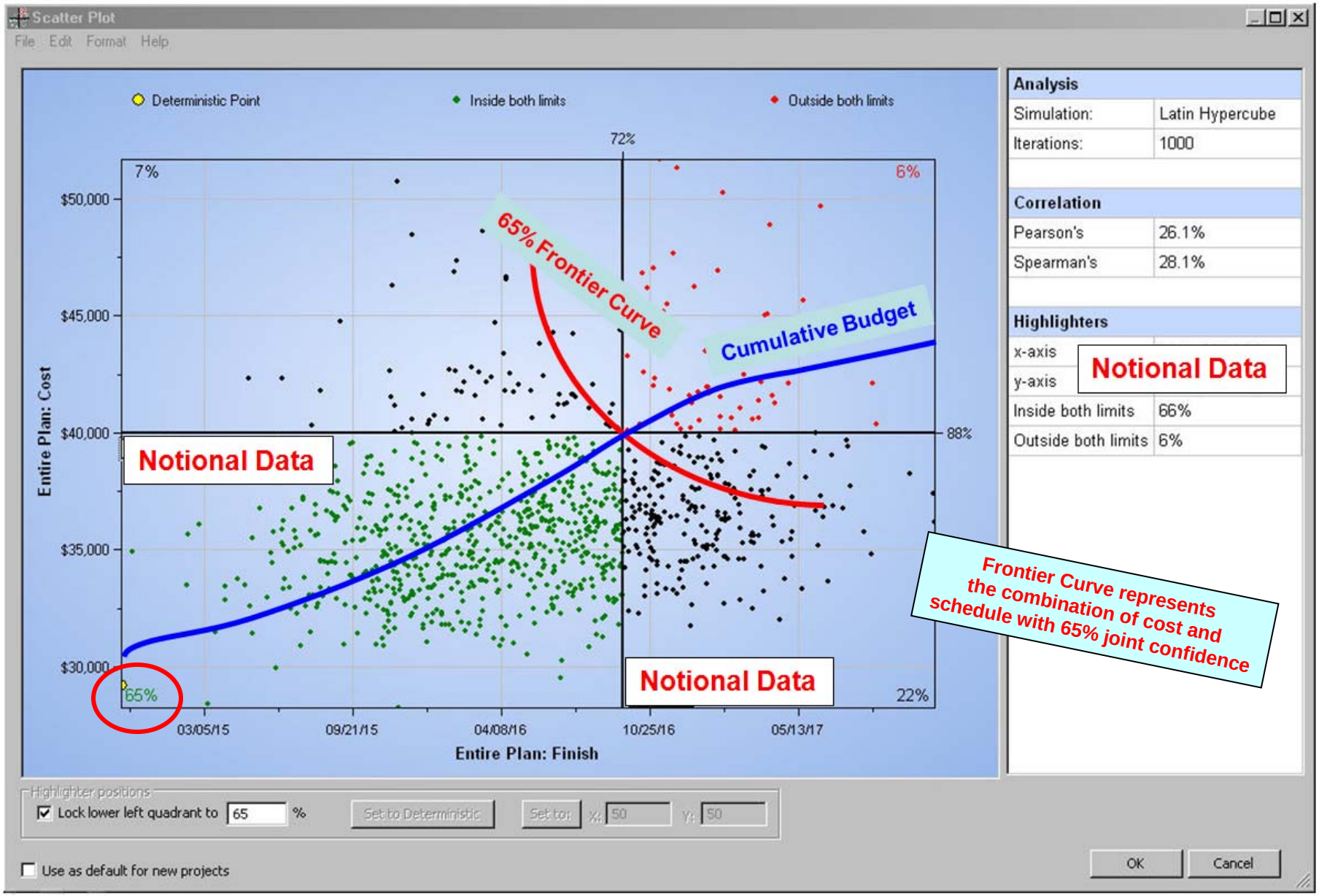
New Confidence Level Policy (Continued)

- Applicable decision authorities may approve a different joint confidence level
- Projects are to be baselined or rebaselined and budgeted at confidence level consistent with the program's confidence level
- At a minimum, projects are to be funded at a level that is equivalent to a confidence level of 50 percent, or as approved by the applicable decision authority

New Confidence Level Policy (Concluded)

- Programs or project's proposed cost and schedule baselines are to be assessed by an independent review team
- Mission Directorates or Mission Support Offices are to confirm that program and projects' life cycle cost estimates and annual budget submissions are consistent

An Example of Joint Cost and Schedule Probability



Draft Implementation Plan

- OCE established four working groups to implement the new Acquisition NPD. Must include
  - Flow-down to lower level documents
  - Communication
  - Training and consulting
  - Done by October 1, 2009
- JCL Working Group has met twice
  - Includes representatives from ESMD, SMD, SOMD, CFO, OCE and PA&E.
  - Plan to add selected center and/or project resource managers
  - Developed draft implementation approach (follows)

JCL Proposed Approach

- All programs and projects must immediately begin to develop and maintain probabilistic joint cost and schedule estimates and confidence levels (JCLs)
  - Include projects within formation as part of Program JCL computation. Deemed a practical consideration to get the agency to the end-state
- Communicate implementation details by way of Strategic Planning Guidance (SPG) and education workshops
- Use phased approach
  - PA&E to help the six programs (and associated projects) develop the JCLs during FY 2009
  - PA&E to provide immediate education to key development centers: GSFC, JPL, JSC, MSFC, & KSC. Provide two half day sessions at HQ and LaRC
  - Provide consulting support and tools to remainder during FY 2010

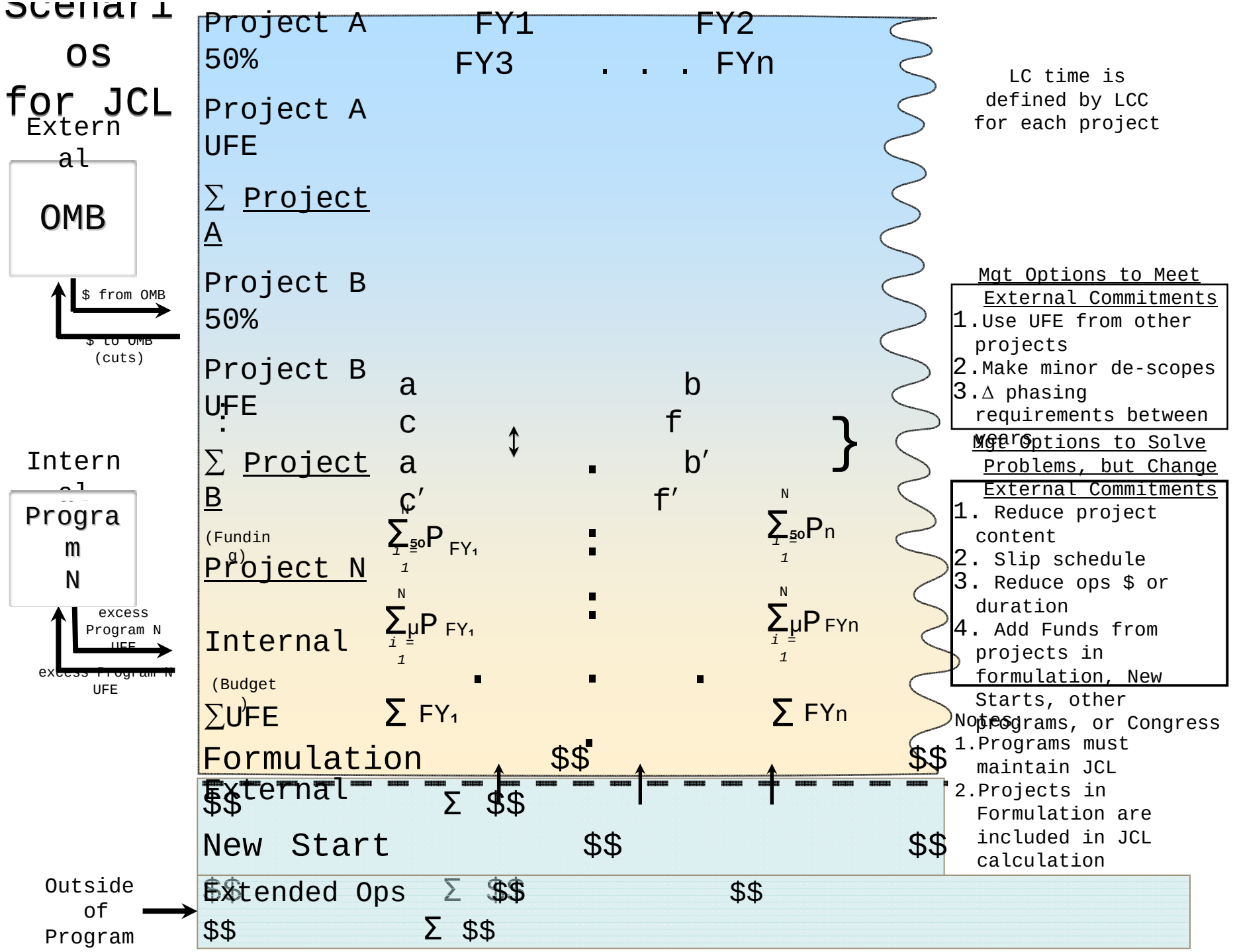
Proposed Approach (Continued)

- Salient provisions of Strategic Planning Guidance
  - PA&E to help six programs to develop and submit JCLs
  - Remaining projects within Development Phases (B, C, D), must submit minimal documentation to demonstrate that projects are resourced adequately, in lieu of JCL documentation
  - Proposed directed projects about to enter Phase A or competed projects about to enter Phase B, must undergo a Basis of Estimate review with PA&E to demonstrate the proposed time and resources are “within the bounds of reasonableness” and not likely to have adverse impact to programs
- At KDP B & C decision milestone events
  - MD’s parent program must demonstrate the program complies with JCL policy with addition of the new project
  - Project must develop and defend its implementation plan (a resource loaded schedule)
  - SRB to provide an assessment of program and project JCL
- At KDP D decision milestone event:
  - Only programs and projects that are on PA&E’s “help” list must produce a JCL
  - SRB’s develop JSL assessments for those programs and projects that have been helped. Otherwise, SRB performs a more general assessment of project’s plan

Proposed Approach (Concluded)

- Programs and projects JCL updates
  - Must be done at KDPs B, C & D
  - Should be done whenever there is a change in Operating Plan (change in requirements, cost, phasing of resources, or schedule)
  - Must be done in support of annual budget submit
- Programs and project report JCL
  - Whenever PMC directs (informed by BRP)
  - As part of annual budget submit

Scenarios for JCL



JCL Methodology and Tools

- Knowledge and tools to develop JCL are available now
  - Parametric approach. Estimate cost and schedule separately, then convolve to form JCL
  - Bottom-up approach via resource-loaded schedule (preferred method because it best reflects the PM's plan)
- Tools include
  - Parametric
    - MS Project and Excel with Monte-Carlo simulation add ins (e.g., @ Risk and Crystal Ball)
    - PA&E-supplied Excel template
  - Bottom-up (resource-loaded schedule)
    - MS Project with add ins
    - PertMaster
  - PA&E-developed Excel template to develop Program JCL